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7 April 1969

Materiel Test Procedure 6-2-230
Electronic Proving GroundU. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

RADIO CONTROL EQUIPMENT

1. OBJECTIVE

The objective of this Materiel Test Procedure (MTP) is to describe a procedure for determining the static and dynamic technical performance characteristics of radio control equipment.

2. BACKGROUND

Combat Development Objective Guide (CDOG), 2 April 1962, paragraph 812C, established a requirement for a device to interconnect radio and wire networks on a push-to-talk basis.

In response to this requirement, remote control unit AN/GSA-7 was developed although it was limited to operation only in configurations which provided a direct current path through the wire circuit.

In order to provide the same features offered by the AN/GSA-7 and the AN/GRA-6 radio set control devices, without the requirement for either DC circuit continuity between the telephone user and the radio set, or the full time monitoring and control of the radio circuit by the radio or switchboard operator, experimental models of Radio Set Control Group AN/GRA-23 were procured and engineering tests were completed in 1964. These test results indicated certain limitations, for example, the equipment was not designed for DC signal operation or compatibility with the AN/GSA-7, nor was it suitable for digital data transmission.

Anticipated requirements for future radio control equipments include the capabilities of remote and local control of radio sets through two-wire or four-wire circuits, and compatibility with voice frequency, teletype, facsimile, and digital data devices.

A basic configuration of radio control equipment is shown in Fig. 1. The general representation of a control unit is shown in Figure 2.

The technical characteristics of radio control equipment are widely varied in nature depending upon specific features and various configurations and modes of operation required for tactical communications. They include one or more of the following:

- a. Push-to-talk control.
- b. Remote changing of the transmitter frequency, or remote selection of other present channels.
- c. Intercommunication and ringing between an operator at a remote point and an attendant at the radio set.
- d. Audio amplification to ensure adequate input to the modulators.

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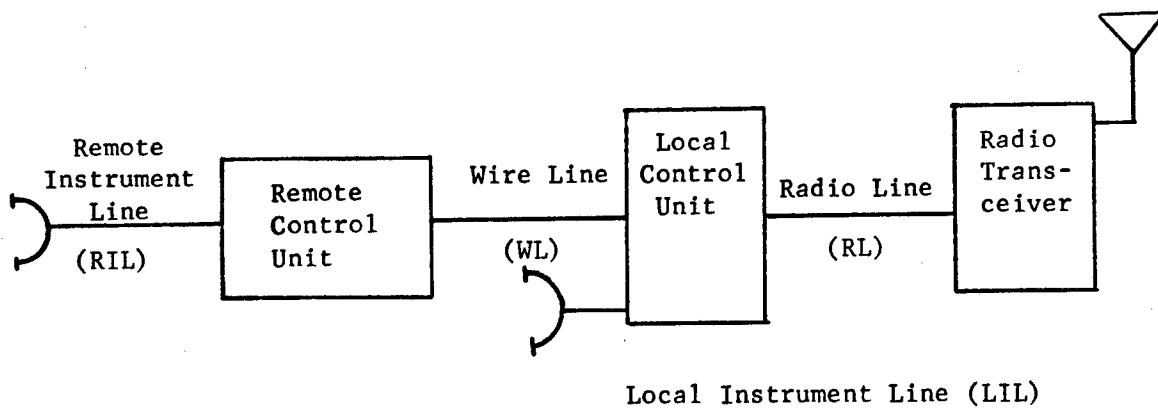


Figure 1. Configuration of Radio Control Equipment

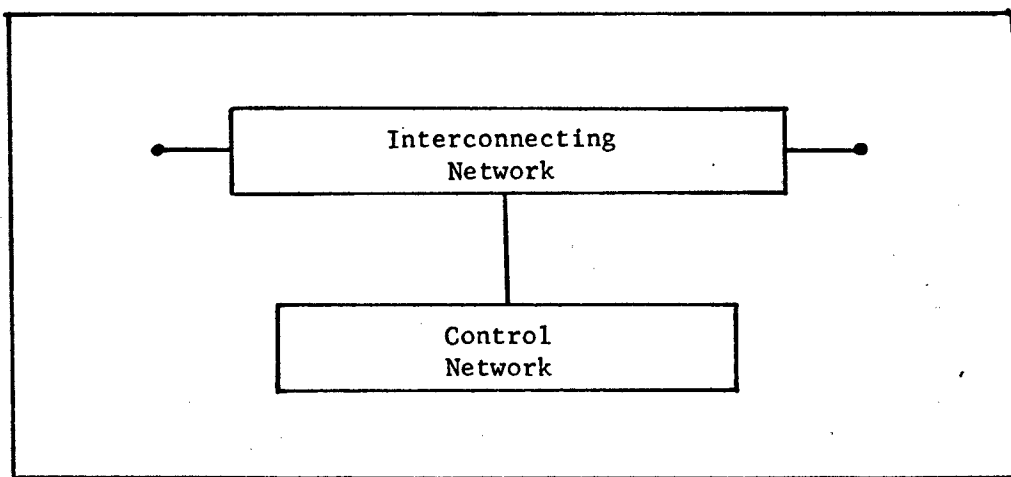


Figure 2. Representation of Control Unit

- e. On-off control of the radio set's basic power supply.

The importance of the equipment mission indicates the need for engineering tests to ensure that this equipment meets applicable requirements and has the specialized characteristics necessary for its intended use.

3. REQUIRED EQUIPMENT

- a. Bench test facilities including 24 volt DC and 115/230 volt, single phase power supplies, single phase, 50 to 400 hertz.
- b. Field test facilities (as appropriate for dynamic tests).
- c. Compatible radio sets.
- d. Handset and Cables compatible with test item.
- e. Current flow test set I-181, or equivalent.
- f. Signal Generator SG-15/PCM, or equivalent.
- g. Frequency Meter, FR-67/U, or equivalent.
- h. Decibel Meter, ME-22/PCM, or equivalent.
- i. Voltmeter AC/DC.
- j. Frequency Selective Voltmeter.
- k. Multimeter, TS-352/U, or equivalent.
- l. Ohmmeter.

4. REFERENCES

- A. Army Signal Corps Technical Requirement SCL-1850, Radio Set Control Group AN/GRA-23
- B. MIL-STD-188, Military Communication System Technical Standards
- C. MIL-STD-461, Electromagnetic Interference Characteristics Requirements for Equipment
- D. MIL-STD-449 (c), Radio Frequency Spectrum Characteristics, Measurements of
- E. MIL-STD-810B, Environmental Test Methods
- F. TM 11-5038, Control Group AN/GRA-6
- G. TM 11-486-8, Electrical Communications Systems Engineering, Special Purpose Systems
- H. TM 11-486-3, Electrical Communications System Engineering, Transmission and Circuit Layout
- I. TM 11-678, Fundamentals of Telephony
- J. Final Report, Radio Set Control Group AN/GRA-23, ETA-FR-122, U. S. Army Electronic Proving Ground, Ft. Huachuca, Ariz. March, 1964
- K. MTP 6-2-015, Amplifiers, General
- L. MTP 6-2-210, Power Supply, Electrical
- M. MTP 6-2-265, Switchboards

5. SCOPE

The scope of this document shall include the testing of those radio control equipments which provide the facilities for remote control and operation of tactical radio sets and for wire communications between remote and local operators.

5.1 SUMMARY

5.1.1 Technical Characteristics

This test procedure describes the tests required to determine and evaluate performance data of radio control equipment by specified static and dynamic tests and by applicable selected procedures of materiel test procedures contained in references 4.K through 4.M. Specific subtests include:

a. Static tests

- 1) Signaling and Supervision - The objective of this subtest is to determine the test item signal generating characteristics, and output responses to input signals.
- 2) Control - The objective of this subtest is to determine the characteristics of the test item which provide transmitter "on-off" control for transmission of voice frequency information.
- 3) Transmission - The objective of this subtest is to determine the transmission characteristics of the interconnecting network in the test item.

b. Dynamic Tests

The objective of dynamic tests is to determine performance and operational limits of the test item when utilized in typical tactical circuits with interfacing equipment and cables. The following tests are included:

- 1) Compatibility with interface equipment
- 2) Control through wire circuits

5.1.2 Common Engineering Tests

The following Common Engineering Tests are required but are not included in this MTP:

- a. 6-2-500 Physical Characteristics
- b. 6-2-502 Human Factors Engineering
- c. 6-2-503 Reliability
- d. 6-2-504 Design for Maintainability
- e. 6-2-507 Safety

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Pre-testing Conditions

a. Personnel responsible for conducting the test should ensure that applicable instructions and design specifications are available.

- b. Reports of previous Radio Control Equipment tests should be available when appropriate.
- c. Operating instructions for test instruments to be used in the conduct of the test should be obtained and available to test personnel.
- d. A test log book or folder should be prepared and utilized to record data during tests.
- e. Availability of the test facilities should be checked and firm scheduling verified.
- f. Ensure that all test instruments have been calibrated to within desired tolerances.
- g. Test personnel should be briefed prior to testing on the purpose of the test and the degree of accuracy expected.

6.1.2 Personnel Orientation

Prior to start of the test program, all test personnel shall accomplish the following:

- a. Become familiar with the technical and operational characteristics of the radio control equipment under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC).
- b. Review all instructional material provided with the commodity equipment by the manufacturer, contractor, or government.

6.2 TEST CONDUCT

6.2.1 Static Tests

6.2.1.1 Signaling and Supervision

6.2.1.1.1 Loop Signaling

- a. Set up equipment according to diagram of Figure 3.
- b. Energize equipment and insure that equipment is in the send mode.
- c. Measure and record the DC voltage at the line terminals.
- d. Change equipment from send mode to receive mode.
- e. Connect a current test set such as Test Set I-181, to the line terminals.
- f. Vary the current supply and determine and record the "actuate" and "release" currents for the particular signal device.
- g. Change equipment from the receive mode to the send mode.
- h. Load the wire line terminals with a 1500 ohm resistor.
- i. Measure and record the output voltage, current and frequency across the load resistor.
- j. Remove the load resistor from the circuit and measure and record the no-load voltage.
- k. Switch equipment to the "receive" mode.
- l. Connect the wire line terminals to a 15-25 Hz variable ringing power source and voltmeter.

m. Measure and record the voltages required to actuate the signal device at 15 Hz and at 25 Hz.

6.2.1.1.2 Wire-to-Radio Signaling

- a. Set up equipment according to Figure 3.
- b. Energize equipment.
- c. Vary the input current with Test Set I-181-B to actuate the radio signal.
- d. Measure and record the output frequency and voltage as shown in Figure 3.
- e. Set up equipment as shown in Figure 4.
- f. Vary the input with the signal generator, in increments from 15 to 110 volts rms.
- g. Measure and record the output frequency and voltage.
- h. Measure and record the sensitivity (least voltage) at selected frequencies between 15 and 3400 Hz to determine the bandwidth over which the detector can be actuated to provide an output.

6.2.1.1.3 Radio-to-Wire Signaling

- a. Set up equipment according to Figure 5.
- b. Vary the input signal in increments from 1570 to 1630 Hz within the range of -15 to +10 dbm.
- c. Measure and record the DC voltage.
- d. Measure and record the selectivity (dbm-least value) at selected frequencies between 18 and 3400 Hz.
- e. Set up equipment according to Figure 6.
- f. Vary the input signal in increments from 1570 to 1630 Hz within the range of -15 to +10 dbm.
- g. Measure and record the output voltage, current, and frequency under the load and no-load conditions shown in Figure 6.
- h. Measure and record the selectivity (dbm - least value) of the tone detection circuit, at selected frequencies between 15 and 3400 Hz.

NOTE: The selectivity measurement given in d. above is used to determine the bandwidth for which the detector can be actuated to provide an output DC closure, whereas the selectivity measurement given in h. above is used to determine the bandwidth over which the detector can be actuated to provide an output

6.2.1.2 Control

NOTE: Applicable tests of the control functions of the test item shall include but not be limited to the following tests.

6.2.1.2.1 DC Control

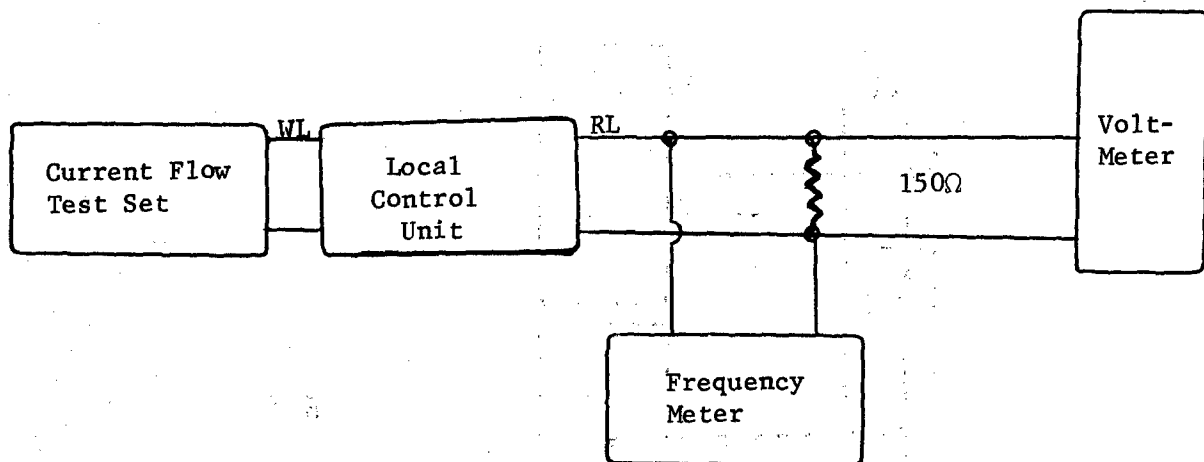


Figure 3. Common Battery-to-Radio Signaling Measurements.

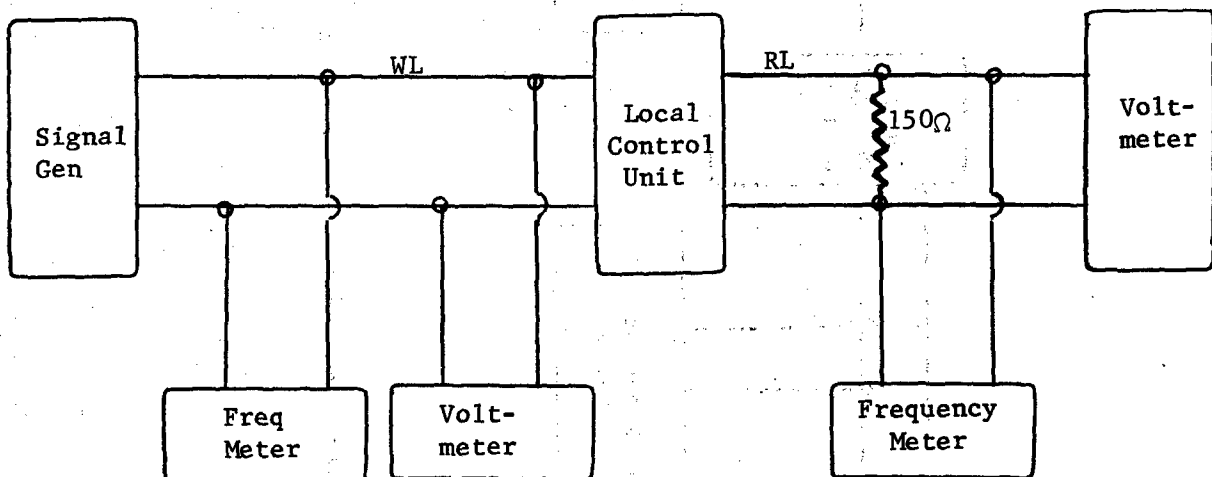


Figure 4. Ringdown Wire-to-Radio Signaling Measurements.

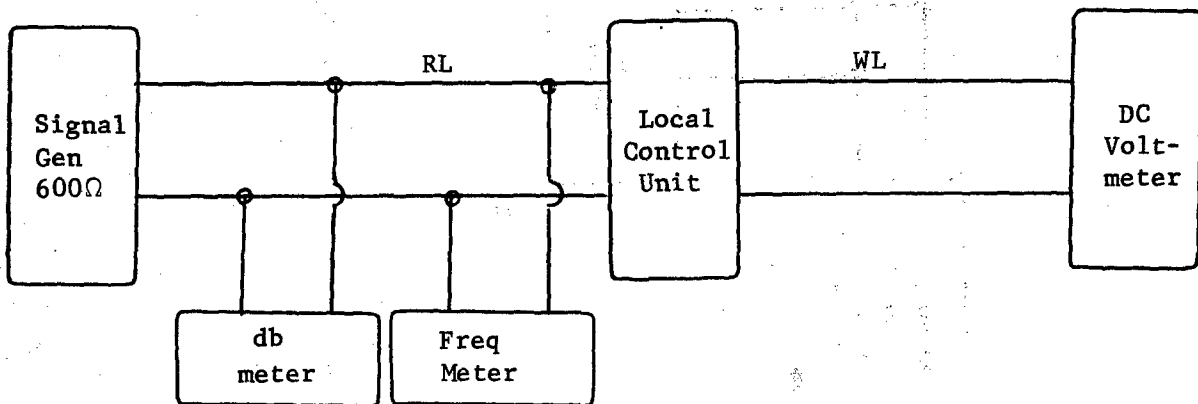


Figure 5. Radio-to-Common Battery Wire Signaling Measurement.

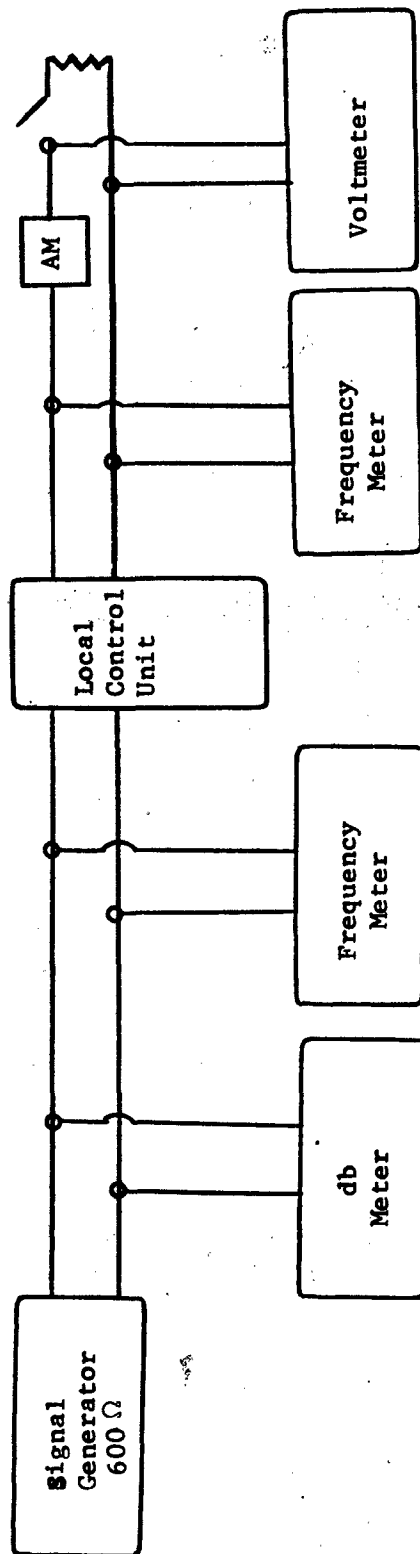


Figure 6. Radio-to-Wire Ringdown Signaling Measurement

a. Vary the DC input current to the local control unit with test set I-181 to provide a DC closure to the transmitter.

b. Measure and record the "activate" and "release" current as indicated by a change in ohmmeter reading across contacts providing DC closure.

6.2.1.2.2 Voice Frequency Control

a. Energize the tone generator circuits.

b. Measure and record the signal generator voltage (rms), frequency, duration of the signal, and rate parameters of the tone generated, using appropriate frequency meters, voltage measuring equipment and oscilloscopes as required.

c. Energize the tone detection circuits.

d. Measure and record, using appropriate equipment, the sensitivity and selectivity of the tone detection circuits, to effect transmitter control.

6.2.1.3 Transmission

The transmission characteristics of the interconnecting network shall be tested as a passive or active (with amplification) transmission link, as applicable, in accordance with selected procedures of MTP 6-2-265, Switchboards, and MTP 6-2-015, Amplifiers, General, in both "transmit" and "receive" modes. The following characteristic tests are applicable:

- a. Insertion loss
- b. Amplitude versus frequency distortion
- c. Harmonic distortion
- d. Delay distortion
- e. Noise
- f. Terminal impedance
- g. Longitudinal balance

6.2.2 Dynamic Tests

NOTE: Dynamic tests shall be performed on radio control equipment in those equipment configurations simulating typical tactical communications system to determine dynamic performance and operational limits.

6.2.2.1 Compatibility with Interface Equipment

- a. Connect the test item to interfacing equipment, as appropriate.
- b. Determine and record the following test item characteristics:

- 1) Execution of signaling and control functions.
- 2) Provision of voice frequency transmission link in the "receive" and "transmit" modes.
- 3) Effects of voice frequency information and spurious signals on control circuit.

6.2.2.2 Control Through Wire Circuit

a. Connect the test item to field telephone cables which provide maximum allowable loss in a tactical circuit (36 db at 1000 Hz for 2-wire user-to-user).

b. Energize equipment.

c. Determine and record the ability of the test item to accomplish the following:

- 1) Execution of signaling and control functions.
- 2) Effects of voice frequency information and spurious signals on the control circuit.

NOTE: If the signaling and control functions are not executed, the limiting cable attenuation and length shall be determined by test to accomplish the function.

6.3 TEST DATA

6.3.1 Static Tests

6.3.1.1 Signaling and Supervision

6.3.1.1.1 Loop Signaling

a. The following data shall be obtained for common-battery signaling circuits:

- 1) DC voltage (line terminals)
- 2) DC closure resistance
- 3) "Actuate" and "release" DC currents

b. The following data shall be obtained for ringdown signal circuits:

- 1) Generator voltage (rms)
- 2) Generator current (rms)
- 3) Generator frequency (Hz)
- 4) Detector actuating voltage (rms) at 15 Hz
- 5) Detector actuating voltage (rms) at 25 Hz

6.3.1.1.2 Wire-to-Radio Signaling

a. The following data shall be obtained for common battery wire-to-radio signaling circuits:

- 1) DC voltage (line terminals)
- 2) DC closure resistance
- 3) "Actuate" and "release" DC currents
- 4) Output frequency (Hz)
- 5) Output voltage (rms)

- 6) Output signal duration (seconds)
- 7) Output signal rate (Number per second)

b. The following data shall be obtained for ringdown wire-to-radio signaling circuits:

- 1) Input frequency (Hz)
- 2) Input voltage (rms)
- 3) Detector bandwidth
- 4) Sensitivity (volt-rms)
- 5) Output frequency (Hz)
- 6) Output voltage (rms)
- 7) Output signal duration (seconds)
- 8) Output signal rate (Number per second)

6.3.1.1.3 Radio-to-Wire Signaling

a. The following data shall be obtained for radio to common battery signaling circuits:

- 1) Input frequency (Hz)
- 2) Input power (dbm)
- 3) Output DC voltage
- 4) DC closure resistance
- 5) Detector bandwidth
- 6) Detector sensitivity (dbm)

b. The following data shall be obtained for radio to wire ringdown signaling circuits:

- 1) Input frequency (Hz)
- 2) Input power (dbm)
- 3) Output voltage (rms) (with load and no-load)
- 4) Output current (rms)
- 5) Output frequency (Hz) (with load and no-load)
- 6) Detector bandwidth
- 7) Detector sensitivity

6.3.1.2 Control

6.3.1.2.1 DC Control

The following data shall be obtained for DC control circuits:

- a. DC voltage (line terminals)
- b. DC closure resistance (ohm)
- c. "Activate" and "release" DC currents

6.3.1.2.2 Voice Frequency Control

The following data shall be obtained for voice frequency control

circuits:

- a. Generator voltage (rms)
- b. Frequency (Hz)
- c. Duration of signal (Millisecond)
- d. Rate of signal
- e. Detector sensitivity (dbm)
- f. Detector selectivity (Hz)

6.3.1.3 Transmission

The following data shall be obtained relevant to the transmission characteristics of the 4 kHz interconnecting network:

- a. Insertion loss
- b. Amplitude versus frequency distortion
- c. Harmonic distortion
- d. Delay distortion
- e. Noise
- f. Terminal impedance
- g. Longitudinal balance

6.3.2 Dynamic Tests

6.3.2.1 Compatibility with Interface Equipment

The following data shall be obtained for compatibility tests:

- a. Description of operational test to conform with operation requirement of individual equipment and configuration.
- b. Description of test signaling and control functions.
- c. Characteristics of voice frequency information signals in "transit" and "receive" mode.
- d. Description of any detrimental effects caused by information signals to control functions, or susceptibility to false operation.

6.3.2.2 Control through Wire Circuits

The following data shall be obtained for control through wire tests:

- a. Maximum attenuation (db) of wire circuit allowing positive signaling and control functions.
- b. Maximum cable length to effect signaling and control function, with description of cable characteristics.
- c. Data of paragraph 6.3.2.1 a through d.

6.4 DATA REDUCTION AND PRESENTATION

- a. Data recorded during section 6.3, TEST DATA, shall be presented as recorded. When required for graphic presentation, selectivity or frequency

responses (amplitude versus frequency) shall be plotted on graph paper.

b. Compare recorded data with values prescribed or specified in appropriate QMR's (Qualitative Materiel Requirements), TC's (Technical Characteristics), and other reference documents and determine whether acceptable for the particular test item.